CLAIMS

1. Method of estimating the channel and the direction of arrival of a signal transmitted by a transmitter and received by an array of antennae after being propagated along at least one path, characterised in that it comprises, for each path, a first step of estimating phase differences (ξ_ℓ) in the signals received by the different antennae in the array, a second step of estimating the angle of arrival (θ) of the signal as well as the phase rotation (ν) undergone by the signal along the said path from the said phase differences and a third step of estimating the attenuation (α) undergone by the signal along the said path from the estimated values ($\hat{\nu}$, $\hat{\theta}$) of the phase rotation and the angle of arrival.

2. Estimation method according to Claim 1, characterised in that the first step comprises, for each signal received (x_ℓ), the minimisation of a first distance between a plurality of values of the said signal ($x_\ell(t)$) taken at a plurality of times (t) and the values taken at the same times of a pilot signal ($b(t)$) which underwent the phase shift and the attenuation to be estimated.

3. Estimation method according to Claim 2, characterised in that the phase shift ξ_ℓ of the signal x_ℓ received by the antenna ℓ is estimated by:

$$\hat{\xi}_\ell = \text{Arc}\tan\left(\frac{S_\ell^1 - S_\ell^2}{S_\ell^3 + S_\ell^4}\right) \text{where}$$

$$S_\ell^1 \stackrel{\Delta}{=} \sum_{t=1}^{T} x_\ell^I(t).b_R(t)$$

$$S_\ell^2 \stackrel{\Delta}{=} \sum_{t=1}^{T} x_\ell^R(t).b_I(t)$$

$$S_\ell^3 \stackrel{\Delta}{=} \sum_{t=1}^{T} x_\ell^R(t).b_R(t)$$

$$S_\ell^4 \stackrel{\Delta}{=} \sum_{t=1}^{T} x_\ell^I(t).b_I(t)$$

where $x_\ell^R(t)$ and $x_\ell^I(t)$ are respectively the real part and the imaginary part of the value of the signal x_ℓ received at time t, $b_R(t)$ and $b_I(t)$ the real part and the imaginary part of the value of the pilot signal at time t and T a time window length.

4. Estimation method according to one of the preceding claims, characterised in that the second step comprises a removal of ambiguity in the phase differences, the removal of ambiguity operating step by step from one antenna to the next as from a reference antenna of the array.

5. Estimation method according to Claim 4, characterised in that the removal of ambiguity uses an affine relationship between the phase shifts and the rank of the antenna in the array.

6. Estimation method according to one of the preceding claims, characterised in that the phase rotation (ν) and the angle of arrival (θ) are estimated from a linear regression on the estimated values of the phase shifts.

7. Estimation method according to Claim 6, characterised in that the phase rotation (ν) and the angle of arrival (θ) are estimated by minimising a second distance $J(\nu,\varphi)=\sum_{\ell=1}^{L}\left(\nu+(\ell-1).\varphi-\hat{\xi}_\ell\right)^2$ where $\hat{\xi}_\ell$ is the estimated value of the phase shift of the signal received by the antenna of rank ℓ, $\varphi=2\pi.\cos(\theta).d/\lambda$ where d is the pitch of the array, λ the wavelength of the signal and L the number of antennae in the array.

8. Estimation method according to one of the preceding claims, characterised in that a new estimation ($\tilde{\xi}_\ell$) of the phase shifts is carried out from the estimated value of the phase rotation ($\hat{\nu}$) and that of the angle of arrival ($\hat{\theta}$).

9. Estimation method according to Claim 8, characterised in that the attenuation (α) is estimated by minimising a third distance between a plurality of values of the said signal ($x_\ell(t)$) taken at a plurality of times (t) and the values taken at the same times as a phase-shifted pilot signal ($b(t)$) of the phase shift values ($\tilde{\xi}_\ell$) newly estimated and having undergone the attenuation (α) to be estimated, the distance being calculated on all the antennae in the array.

10. Signal reception device comprising an array of antennae (300_i) and estimation means (330_i) adapted to implement the steps of the method according to one of the preceding claims.

11. Reception device according to Claim 10, characterised in that it comprises, at the output of each antenna, a plurality of filters (310_i) adapted to the different signal propagation paths and a plurality of estimation means (330_i), each estimation means being associated with a path (i) and receiving the outputs of the filters (310_i) adapted to the corresponding path.

12. Reception device according to Claim 11, characterised in that it comprises channel formation means (320_i), each channel formation means (320_i) being associated with a path (i) and receiving from the estimation means (330_i) associated with the said path the estimation $\hat{\theta}_i$ of the angle of arrival of the said path in order to form a channel in the corresponding direction.

13. Reception device according to Claim 12, characterised in that each channel formation means (320_i) also receives from the estimation means ($330_{i'}$) other than the associated estimation means (330_i) the estimations ($\hat{\theta}_{i'}$, $i' \neq i$) of the angles of arrival of the other paths in order to place zeros in the corresponding directions.

14. Reception device according to Claim 12 or 13, characterised in that it also comprises a plurality of complex multiplication means (340_i), each complex multiplication means being associated with a path (i) and multiplying the output of a channel formation means (320_i) by the complex coefficient $\hat{\alpha}_i . e^{-j\hat{\nu}_i}$ where $\hat{\nu}_i$ and $\hat{\alpha}_i$ are the estimated values of the phase rotation and of the attenuation coefficient supplied by the estimation means associated with the said path.